UNITED STATES AIR FORCE
611TH CIVIL ENGINEER SQUADRON

ELMENDORF AFB, ALASKA

Final

Engineering Evaluation/Cost Analysis
Million Gallon Hill Source Area of the West Unit
Galena Airport, Alaska

February 1996

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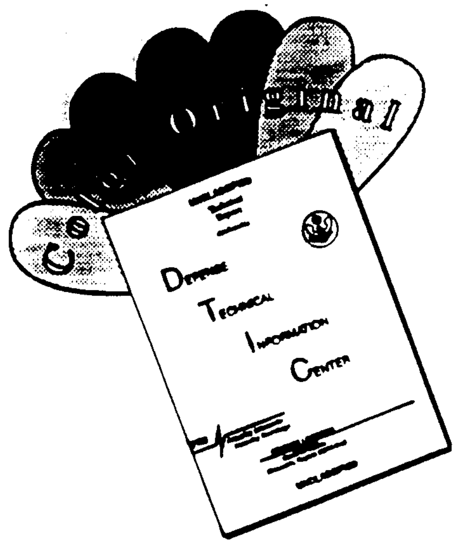

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This Engineering Evaluation/Cost Analysis (EE/CA) has been developed by the U.S. Air Force for the Million Gallon Hill source area of the West Unit (IRP Site ST009) at Galena Airport, Alaska in response to the presence of contaminated soils and the existence of free phase hydrocarbons floating on the groundwater. Four alternative non-time critical removal actions were evaluated for the Million Gallon Hill source area. These were: 1) No action; 2) Product recovery and soil bioventing; 3) Containment; and 4) Product recovery, soil excavation, and treatment. All four alternatives were evaluated on the basis of effectiveness, implementability, and cost. The second alternative, product recovery and soil bioventing, was found to be most feasible in terms of effectiveness, implementability, and cost.

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List of Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Constituents of concern
COPCs	Constituents of potential concern
DRO	Diesel range organics
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
GRO	Gasoline range organics
IRP	Installation Restoration Program
LNAPL	Light, nonaqueous phase liquids
MCL	Maximum contaminant level
NPL	National Priorities List
POL	Petroleum, oil, and lubricants
RAO	Removal action objective
RI	Remedial investigation
TCE	Trichloroethene
USAF	United States Air Force
USTs	Underground storage tanks
UTLs	Upper tolerance limits
VOCs	Volatile organic compounds

United States Air Force
611th Air Support Group
Installation Restoration Program

DECISION DOCUMENT DECLARATION

SITE NAME AND LOCATION

Galena Airport
Million Gallon Hill Source Area of the West Unit (ST009)
Galena, Alaska

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected removal action for the Million Gallon Hill source area of the Installation Restoration Program (IRP) site ST009, otherwise known as the West Unit at Galena Airport, Alaska. The removal action was chosen in accordance with the National Contingency Plan (NCP 40 CFR 300.415), which states that the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or the threat of release. This decision is based on the administrative record for this site, specifically the draft Remedial Investigation (RI) Report (March 1995). The information from the RI Report is summarized, along with an analysis of potential removal action alternatives, in the attached Engineering Evaluation/Cost Analysis (EE/CA).

The USAF is the lead agency for this decision, and as such has the authority to choose the removal action [CERCLA, 42 USC 9604(a); Executive Order 12580, Section 2(d), 52 F.R. 2923, 23 Jan 87]. The Alaska Department of Environmental Conservation (ADEC) has participated in the scoping of the site investigation and in the review of the EE/CA.

ASSESSMENT OF THE SITE

Leaks and spills have resulted from fuel handling and storage practices at Million Gallon Hill. Hydrocarbon contamination, in the form of benzene, toluene, xylene, and gasoline and diesel range organics in soil and water at the site, is high enough to pose a threat to the public health and welfare. Workers are employed in the buildings that lie atop and adjacent to Million Gallon Hill. These workers could potentially be exposed through dermal contact, ingestion, or inhalation of dust or fumes form the contaminated soil and water. Removing the free-phase hydrocarbons from the groundwater and remediating the contaminated soils at Million Gallon Hill will eliminate the potential for further contaminant migration as well as the risk to human and ecological receptors.

DESCRIPTION OF THE SELECTED REMEDY

A non-time-critical removal action will be conducted in response to the presence of petroleum hydrocarbons in soils and groundwater at Million Gallon Hill. The purpose of the removal action is to eliminate the continuing source of contamination in the soil and groundwater and to reduce the risk to human and ecological receptors. The selected remedy at Million Gallon Hill involves the removal of free product from the groundwater via product recovery wells and the remediation of soils using bioventing technology.

PUBLIC COMMENT

The public comment period for the attached EE/CA was from 28 June 1995 to 30 July 1995. No public or regulatory agency comments were received.

DECLARATION

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable, and is cost effective. The attached EE/CA examines several alternatives for the remediation of the site, with the finding that the selected remedy scores highest in effectiveness and implementability.

Samuel C. Johnson

SAMUEL C. JOHNSON III, Colonel, USAF
Commander

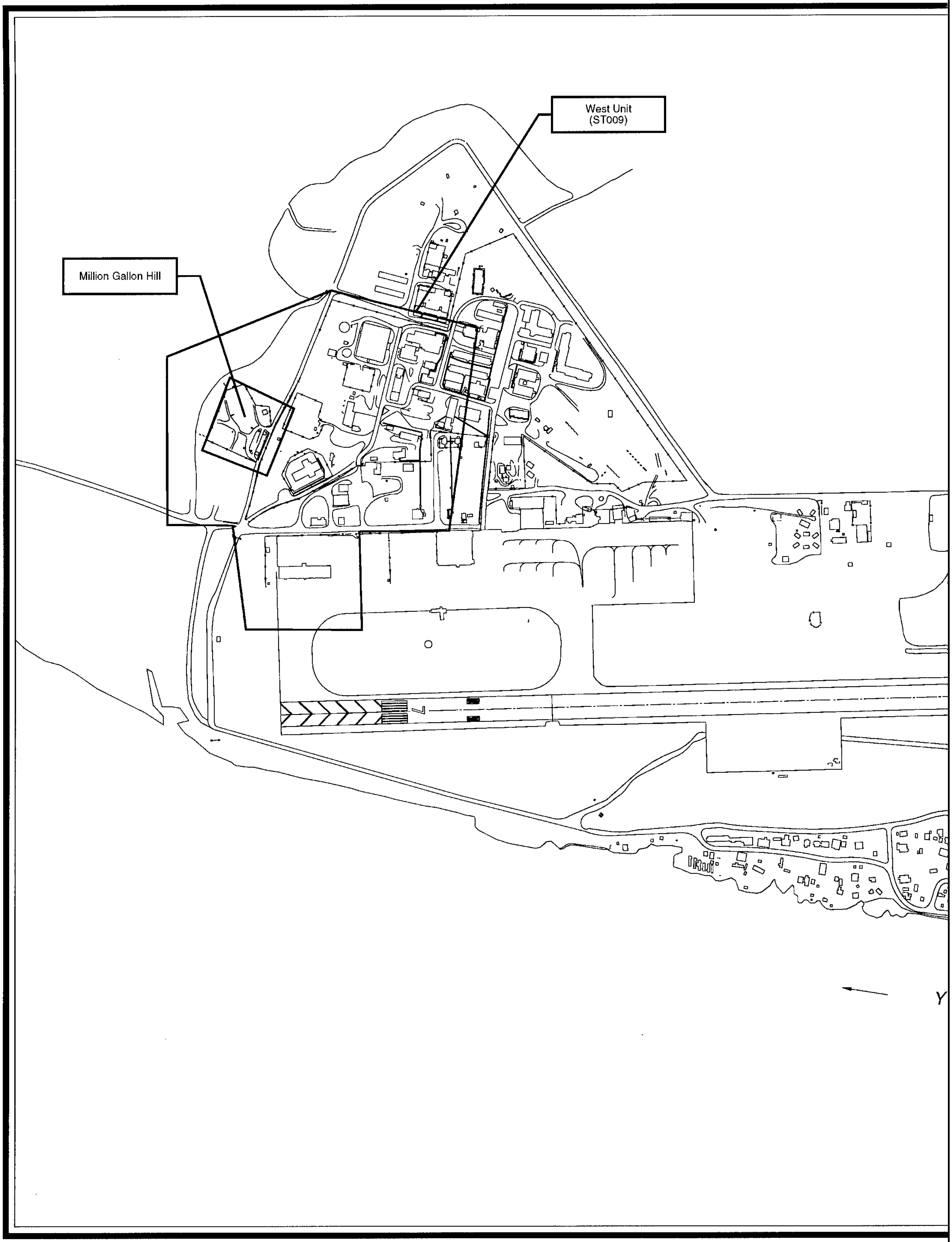
Date JAN 8 1996

Section 1 INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) has been developed by the U.S. Air Force (USAF) for the Million Gallon Hill source area of the Installation Restoration Program (IRP) site ST009, otherwise known as the West Unit at Galena Airport, Alaska. A non-time-critical removal action will be conducted in response to the presence of contaminated soils and the existence of free phase hydrocarbons floating on the aquifer. The contaminated soils are a possible threat to human receptors who are employed (or will be employed) in the buildings located within and adjacent to this site. The soil contamination includes diesel range organics (DRO), benzene, and other volatile organic compounds (VOCs) and will be addressed as part of this removal action. The site location is shown in Figure 1-1.

Environmental conditions at this site have been evaluated in accordance with the U.S. Environmental Protection Agency (EPA) interim final document *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* dated August 1993. Although this installation is not included on the National Priorities List (NPL), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance is followed for all investigations and response actions.

The purpose of this EE/CA is to initiate a removal action to the conditions described above and to prevent current and future receptors from being exposed to contamination. The action that results from this document may or may not be the final action. The action will address a free product layer and the highest areas of soil contamination. Non-time-critical removal actions, as they are defined in the guidance, are undertaken to remove sources of contamination that are contributing to either risk in place or risk through migration to human or ecological receptors (or to other media, such as groundwater). The final remedial action would be selected on the basis of the combined results of the remedial investigation (RI), risk assessment, any other studies (such as treatability or feasibility studies and the results of this removal action). The remedial action would address contamination that exists outside of the source area, as well as any contamination remaining in the source area after the removal action.


West Unit
(ST009)
Million Gallon Hill

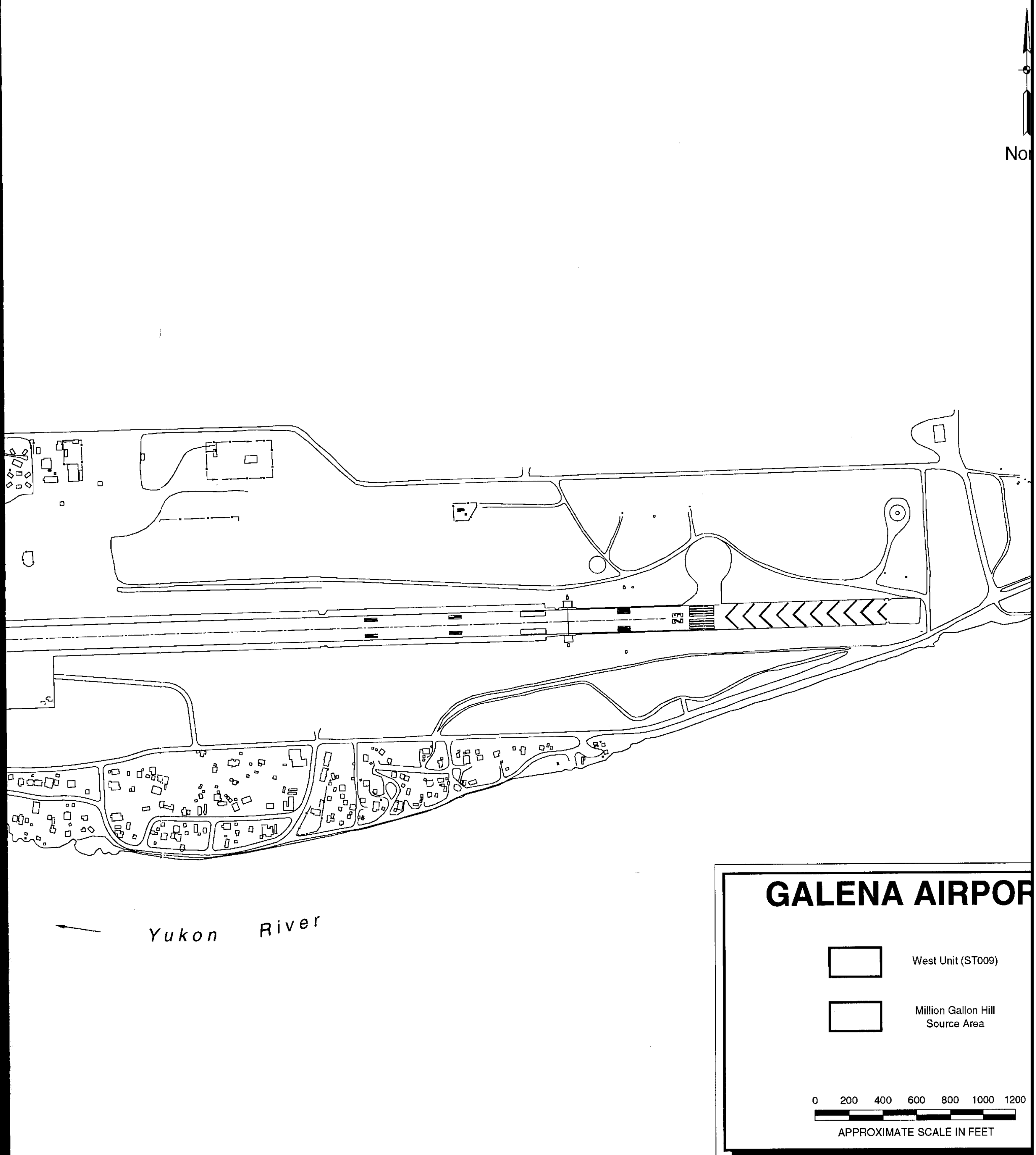


Figure 1-1. Study Are

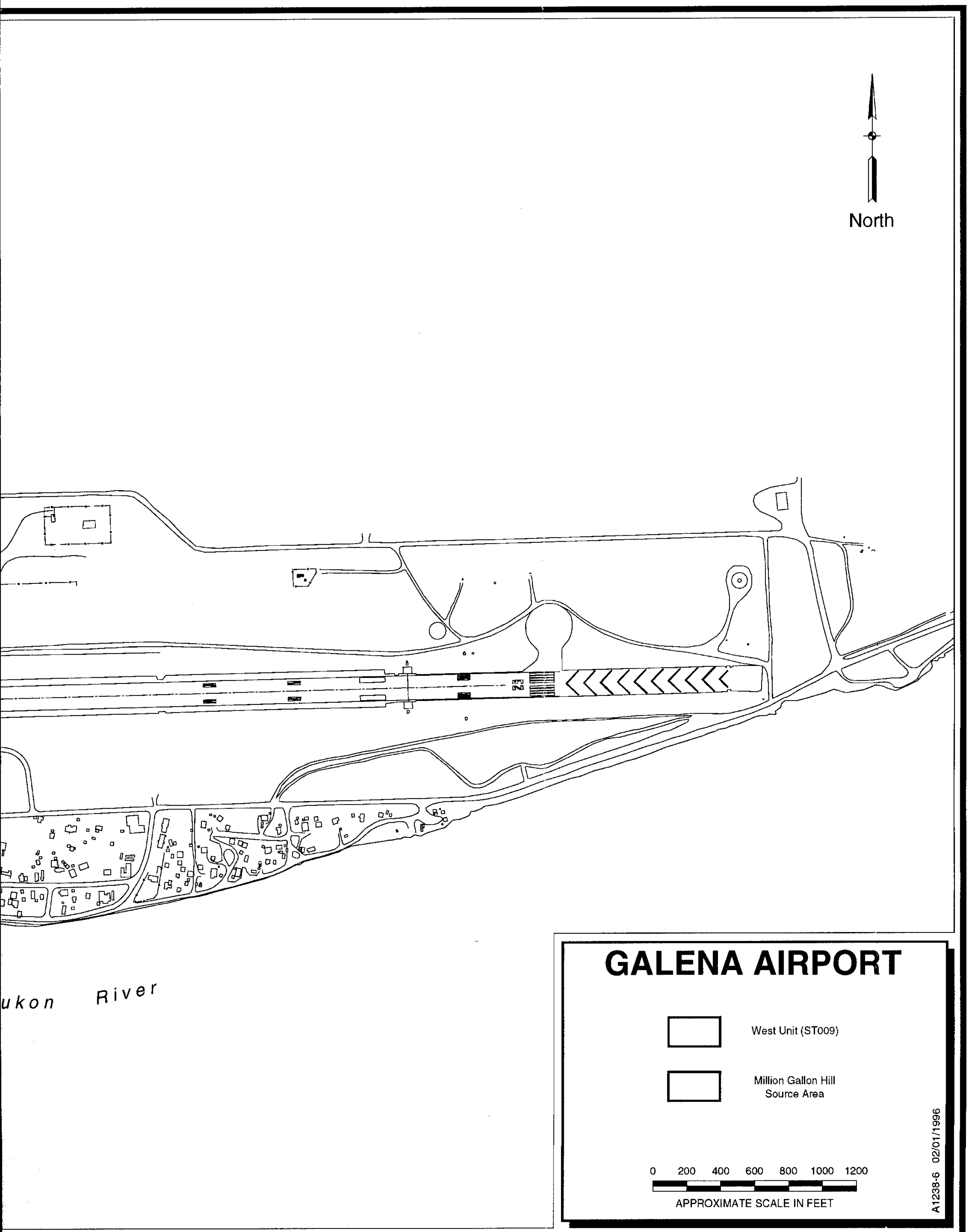


Figure 1-1. Study Area

Section 2
SITE CHARACTERIZATION

Site Description and Background

The Million Gallon Hill source area is one of several source areas in the West Unit (shown in Figure 1-1). The site is located on the extreme western boundary of the airport, outside of the dike road boundary. The primary source of contamination was from several large storage tanks that were located on the hill. The release from the storage tanks has contaminated the soil and groundwater at this site and has allowed a free-phase hydrocarbon layer to form on top of the aquifer. A complete discussion of the site description and background is provided in the draft final *Remedial Investigation Report, Galena and Campion Air Force Station, Alaska* (USAF, 1995).

Sludge from the periodic cleaning of the large bulk fuel (petroleum, oil, and lubricants, POL) tanks at Million Gallon Hill (underground storage tanks, USTs No. 37 and No. 38) has been placed in drums for off-base disposal in recent years, but in earlier years the sludge is presumed to have been allowed to weather on the ground, causing the release described above. Occasionally, water from these tanks needed to be drained and the drained water-fuel mixture was taken to a waste fuel tank (USAF, 1995). Leaks and small spills may have resulted in further contamination of soils around and beneath tank areas.

The result of these releases is the presence of soil contamination beneath the tank locations, the existence of a light, nonaqueous phase liquid (LNAPL) atop the groundwater, and other groundwater contamination in the form of dissolved-phase trichloroethene (TCE), benzene, and other fuel-related compounds. This EE/CA addresses only the soil contamination and the LNAPL; it is expected that the dissolved-phase constituents present in the groundwater will degrade naturally over time, without posing an unacceptable risk to human or ecological receptors.

The extent of soil contamination is defined by the presence of DRO at levels exceeding those dictated by the applicable and relevant or appropriate requirements (ARARs) (see Section 3). The data associated with this site have been generated through the investigations of several environmental contractors. The LNAPL has been found in two monitoring wells and has been described as a very dark brown, weathered free-product layer.

Figure 2-1 shows the concentration contours for DRO in soil at the Million Gallon Hill source area. Figure 2-2 shows a cross section through the site with the relative locations of the monitoring wells and the LNAPL.

2.1 Previous Removal Actions

There have been no previous removal actions completed at this source area.

2.2 Nature and Extent of Contamination—Data Summary

This section presents a brief discussion detailing the conclusions drawn from the RI of this source area. A complete discussion of the nature and extent of contamination is provided in the draft final *RI Report* (USAF, 1995).

The latest field investigations at the Million Gallon Hill source area included the sampling of all existing groundwater monitoring wells, the installation and sampling of eight new wells, the completion of one soil boring, and the collection and analysis of surface soil samples. Field screening activities were also conducted at this source area to help direct the RI sampling efforts.

The results of soil sampling at the Million Gallon Hill source area showed evidence of fuel contamination in the boring for monitoring well 09-MW-01, where DRO were present at 230 mg/kg. A surface soil sample collected just north of the tank farm fence (09-SS-01) also exceeded State of Alaska cleanup levels with 320-mg/kg DRO. This surface detection may be the result of runoff from

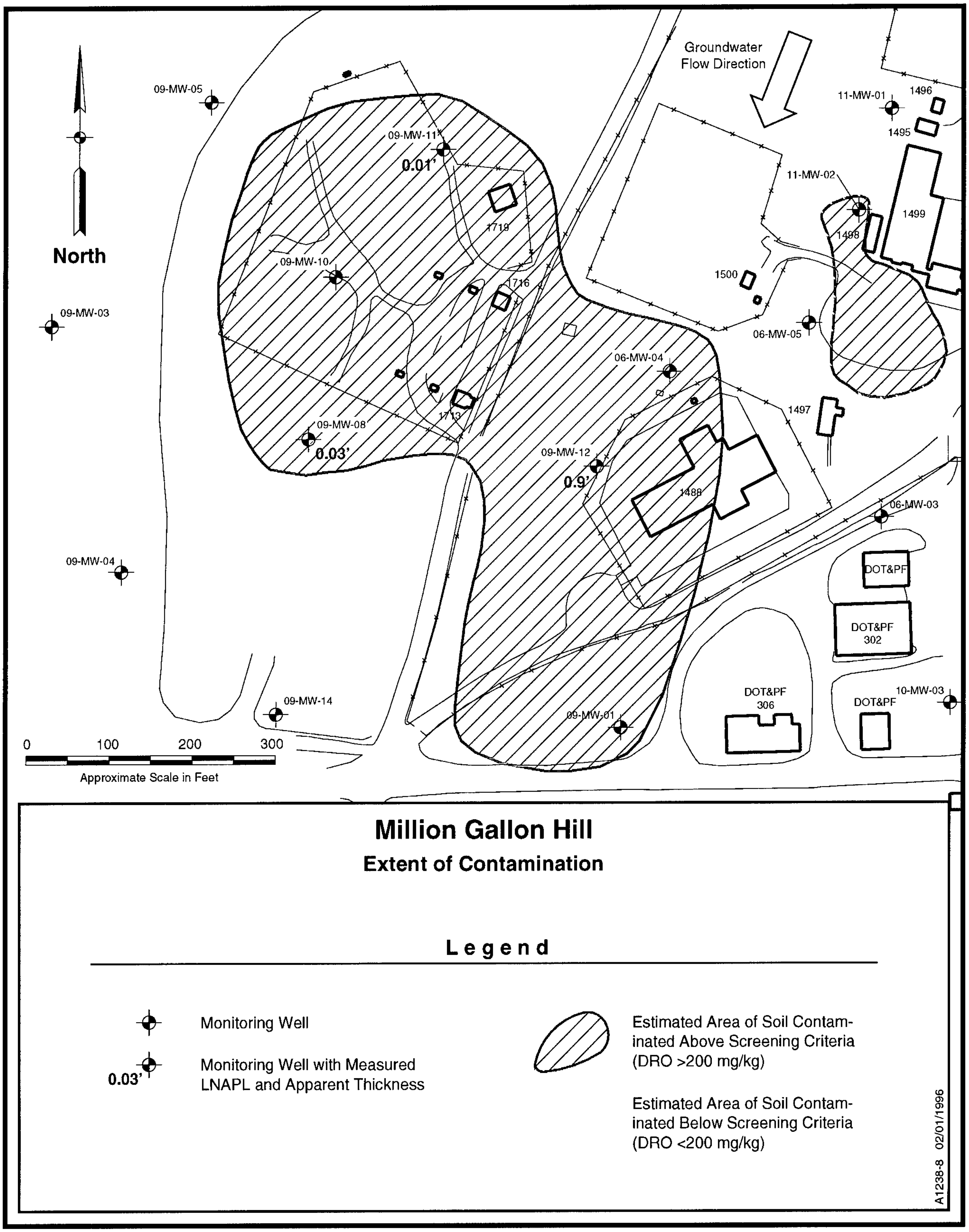


Figure 2-1. Extent of Contamination at Million Gallon Hill

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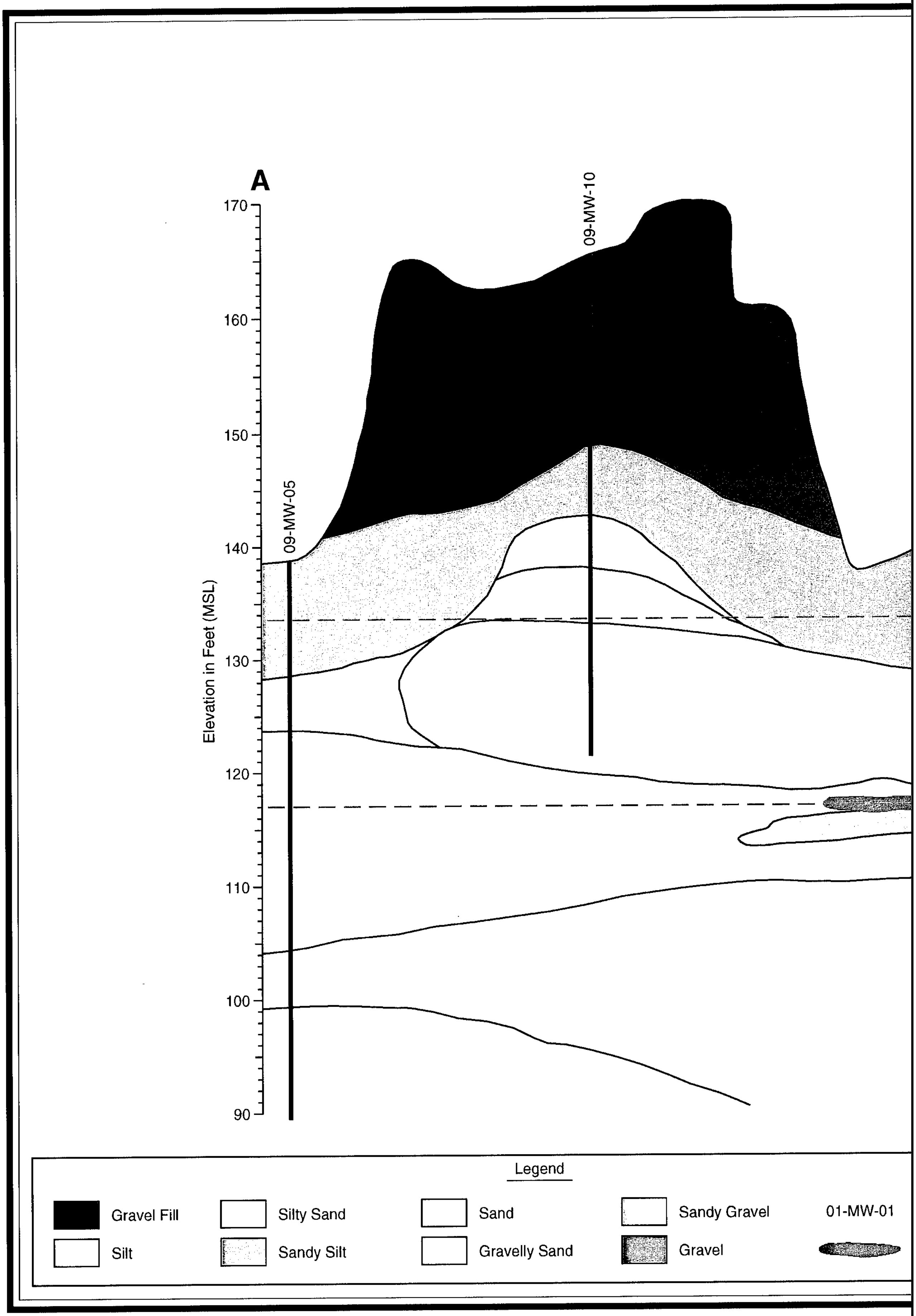
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170
160
150
140
130
120
110
100
90
Elevation in Feet (MSL)
09-MW-05
09-MW-10
Legend
Gravel Fill
Silt
Silty Sand
Sandy Silt
Sand
Gravelly Sand
Sandy Gravel
Gravel
01-MW-01

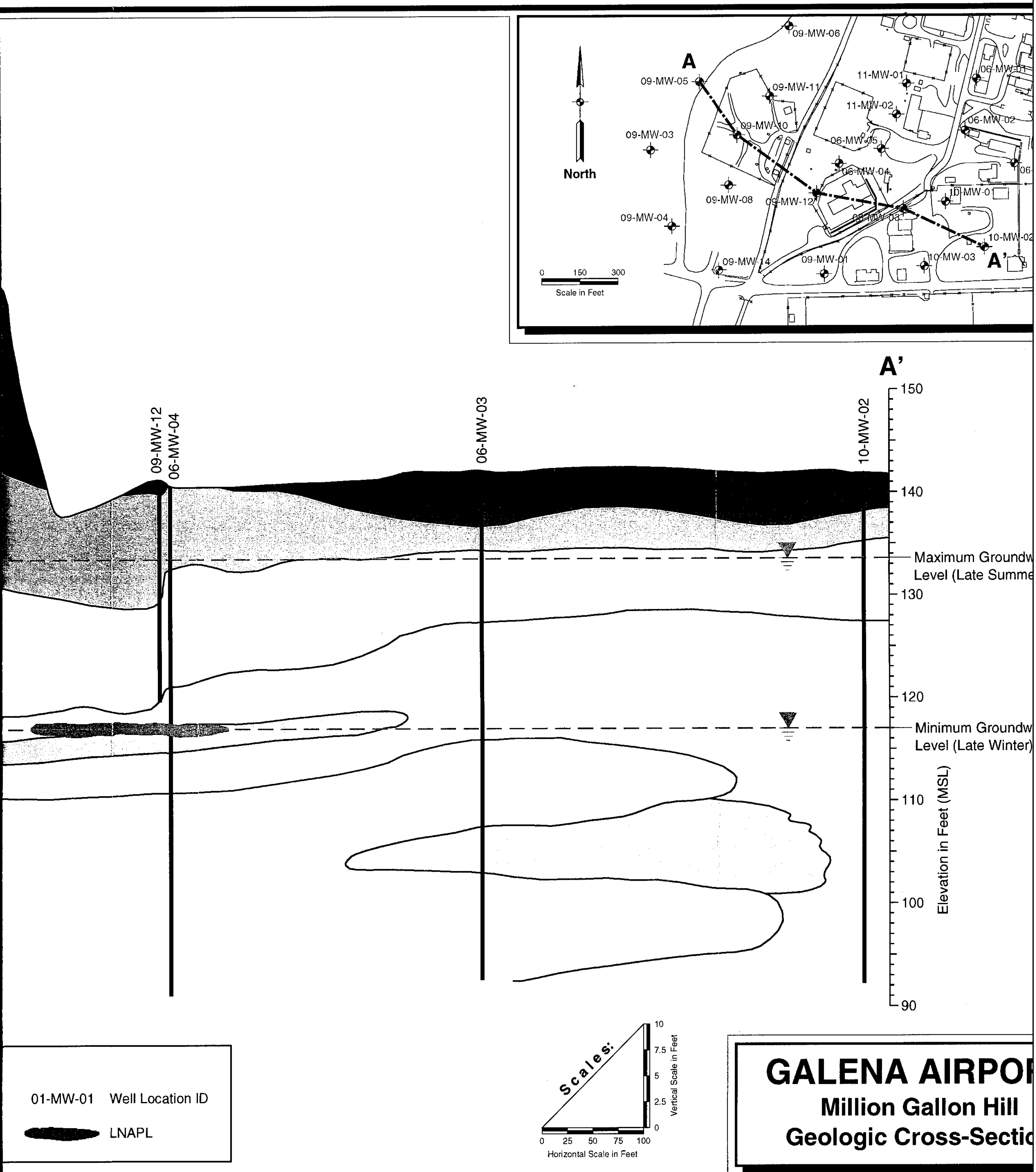

Figure 2-2. Geologic Cross-S

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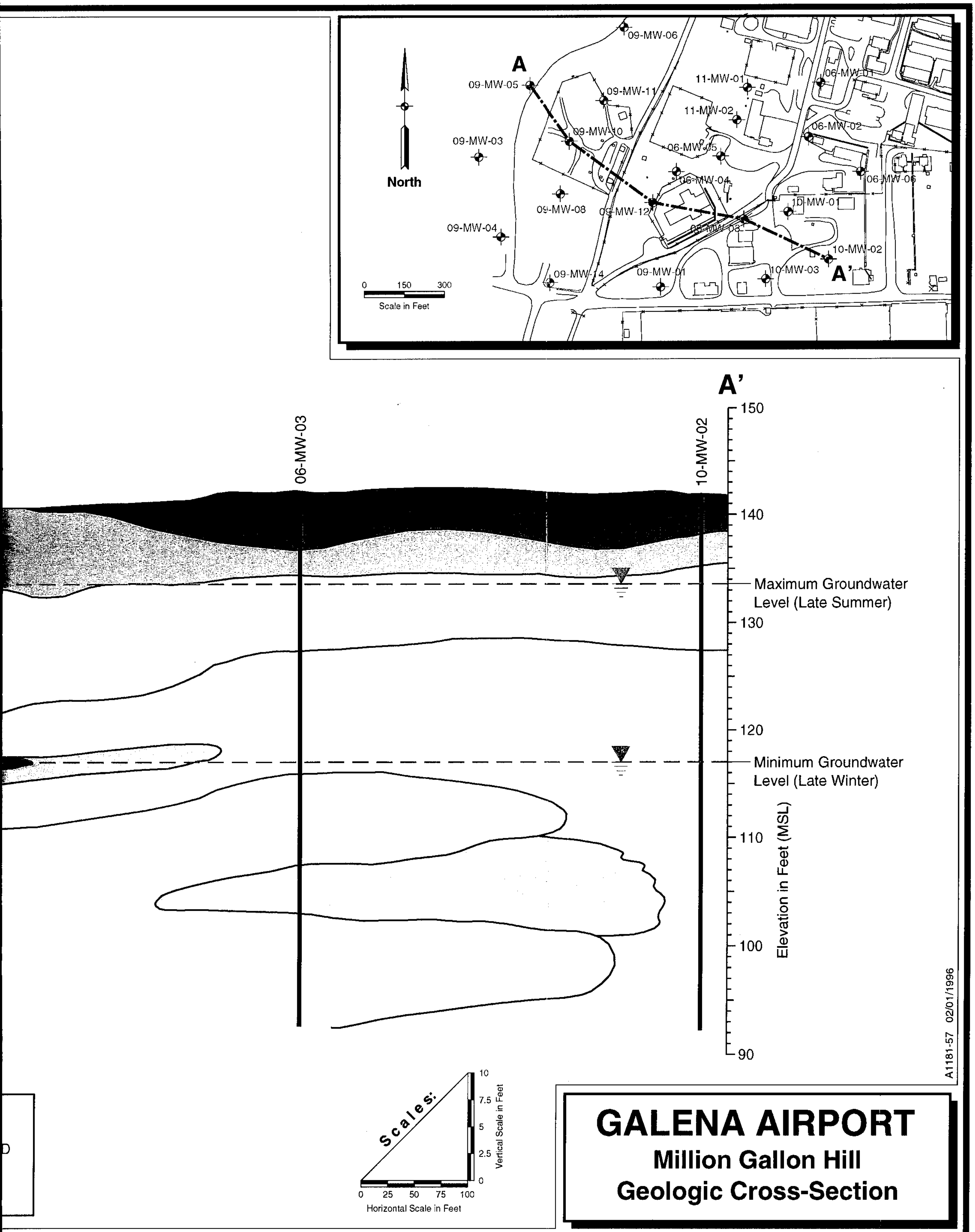


Figure 2-2. Geologic Cross-Section

within the tank farm, since it was collected near an erosion gully (USAF, 1995).

A 1992 study (detailed in the *Monitoring Well and Borehole Report, USTs Nos. 37, 38, and 49* [USAF, 1992]) that preceded the RI revealed that samples soil borings (drilled around former UST Nos. 37 and 38) and monitoring well soils contained fuel constituents at unacceptable levels. The monitoring wells installed during this study that contained these constituents consisted of 09-MW-08, -11, -12. The results from both of these studies form the basis for the nature and extent of soil contamination.

The results of the RIs at the present time indicate contamination in the form of diesel range fuel constituents that cover the area shown in Figure 2-1 to depths of over 40 ft. This contamination provides a continuing secondary source that is contributing to the groundwater contamination. The areas of highest contamination exist around and downgradient from the former location of UST Nos. 37 and 38. It appears that free-phase fuel constituents have migrated downgradient from the former tank locations and have formed an LNAPL atop the groundwater south and east of the hill. The nature of the groundwater fluctuation (as illustrated in Figure 2-2) allows the LNAPL to form a "smear zone" of soil contamination of up to 20 ft or more. It is assumed that soil contamination exists in the area shown from 10-15 ft above the highest level of groundwater elevation to the lowest level of groundwater elevation.

The following paragraphs provide individual results from groundwater investigations and are provided for informational purposes only.

The analytical results for groundwater from Million Gallon Hill showed benzene, DRO, gasoline range organics (GRO), and other fuel-related compounds detected in 06-MW-04 and 09-MW-08, -10, -11, and -12. All of these wells are located within or immediately south and east of the Million Gallon Hill impoundment. Three of these wells, 09-MW-08, -11 and -12, contain free product that is very dark brown in color. The thickness of LNAPL in these wells was measured at 0.03 ft, 0.01 ft, and 0.9 ft, respectively, during the 1992 study (USAF, 1992). With the exception of 06-MW-04 and 09-MW-08, these wells also contain other benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds above the screening criteria. Further to the south of Million Gallon Hill, three wells were found to contain benzene above the 5-µg/L maximum contaminant level (MCL). Groundwater samples from 09-MW-01 were found to contain approximately 100 µg/L benzene in 1992, 1993, and 1994. Samples collected in 1992 from 09-MW-02 and 09-MW-04 did not contain benzene above the MCL, but 1993 and 1994 samples from these wells did contain benzene in excess of the MCL. Concentrations of TCE have also been detected in groundwater from the Million Gallon Hill area. Only the 1994 groundwater sample from 06-MW-04 exceeds the 5-µg/L MCL, with 12.3-µg/L TCE. The groundwater monitoring wells that flank Million Gallon Hill to the north and west do not contain any fuel- or solvent-related contaminants above the screening criteria.

Arsenic and lead concentrations slightly exceed the MCLs (0.05 and 0.015 mg/L, respectively) in a few groundwater samples from Million Gallon Hill. Arsenic was detected in a sample from 09-MW-12 at 0.060 mg/L. Lead was detected in 09-MW-03 at 0.018 mg/L in a 1992 sample; it was not detected above the concentration found in method blanks in 1993. Lead was also detected in a sample from 09-MW-10 at a concentration of 0.020 mg/L.

Monitoring well 09-MW-15 was placed downgradient of the plume identified by field screening activities. A groundwater sample collected from this well in September 1993 was found to contain benzene at 5.49 µg/L, just above the MCL of 5 µg/L. A sample collected in September 1994 from this well contained only 0.680 µg/L benzene.

2.3 Risk Evaluation

The risks associated with the contamination in the soils and groundwater at this source area will be addressed under the baseline risk assessment (in press, 1995). This streamlined risk evaluation is focused on current and future receptors in an industrial scenario. These receptors are daily workers that are employed in the buildings that lie atop Million Gallon Hill as well as those that are adjacent to the site to the south and to the east. The potential pathways of exposure are as follows:

- Dermal contact, ingestion, and inhalation of fugitive dust from surface soil contamination;
- Dermal contact, ingestion, and inhalation of dust from intrusive activities for construction scenarios; and
- Inhalation of vapors as they migrate to the surface and collect and concentrate in the buildings.

The specific constituents of potential concern (COPCs), identified through the RI, include only DRO and lead. Additional COPCs that were identified during the 1992 study include benzene (total BTEX was also identified as exceeding the cleanup level). COPCs are simply those constituents whose screening level criterion has been exceeded in at least one sample. The screening level is defined in the *RI Report* (USAF, 1995). The list of COPCs is reduced to a list of constituents of concern (COCs) by statistical and intuitive evaluation. Of the COPCs, only two compounds are retained as COCs: DRO and benzene. Lead was eliminated by statistical comparison with the background data set and by intuitive analysis. Only one exceedence of the health-based criterion was noted. This concentration of lead (2080 mg/kg) exceeded the screening criterion (400 mg/kg) and the background upper tolerance limit (UTL) (17 mg/kg). However, concentrations of this order of magnitude were found in only one surface sample (0-2 ft) in a separate investigational area that is not addressed in this EE/CA.

It is assumed that DRO are the most prevalent of the two COCs and drive both the volume of contaminated soil and the level of effort and duration required for a response action. The maximum concentration of benzene detected in a soil sample was 14.3 mg/kg. The maximum concentration of DRO (assumed to be the major component of total petroleum hydrocarbons results from the 1992 study) was 43,300 mg/kg in the soil collected from the installation of 09-MW-08. The cleanup level for this compound is 200 mg/kg and is detailed in the following section. On the basis of the RI findings, a removal action was deemed necessary (by the Air Force) to protect current and future receptors in this area.

The following paragraphs describe the health effects from exposure to benzene and diesel fuel.

Benzene

Benzene is a colorless liquid with a sweet odor. It is volatile, soluble in water, and very flammable. It is used in industry to produce other chemicals, and to manufacture some types of rubber, lubricants, dyes, detergents, and pesticides. Industrial processes are the main source of benzene in the environment. Benzene in water and soil may evaporate into the air where it is degraded in a few days. Benzene remaining in soil and water may also degrade in those media, or may migrate into groundwater.

Most people are exposed to a small amount of benzene on a daily basis. The major sources of benzene exposure are gasoline, automobile exhaust, industrial emissions, and tobacco smoke. Brief exposure (5-10 min) to very high levels of benzene in air (10,000-20,000 ppm) can result in death. Exposure to lower levels (700-3000 ppm) may

cause drowsiness, dizziness, headaches, and unconsciousness. These effects usually disappear once exposure is interrupted. Ingestion of foods or beverages containing high levels of benzene may result in vomiting, dizziness, convulsions, and death. Human health effects associated with ingestion of lower levels of benzene are currently unknown. Dermal contact with benzene may cause redness or blisters.

The majority of information on the effect of long-term exposure to benzene is from studies involving occupational exposure of employees to ambient levels of benzene far greater than the levels normally encountered by the general population. Inhalation of benzene for long periods of time may cause adverse effects in the tissues that form blood cells, especially the bone marrow. This may result in disruption of normal blood production and cause a decrease in important blood components, leading to anemia or excessive bleeding. Blood production may return to normal upon disruption of exposure. Benzene exposure can be harmful to the immune system, enhancing the probability of infection and perhaps lowering the body's defense against tumors. Long-term exposure to benzene in the air causes leukemia and has been associated with genetic changes.

Long-term exposure to benzene may also damage the reproductive organs. Some female workers who breathed high levels of benzene for many months experienced irregular menstrual cycles. Upon examination of these women, decreased ovary size was revealed. However, exposure levels were not documented and it was not proven that benzene was responsible for the effects. Currently it is not known what effects benzene exposure has on the developing fetus in pregnant women. Studies in which pregnant laboratory animals were exposed to benzene resulted in low birth weights, delayed bone formation, and bone marrow damage.

Human health effects associated with long-term exposure to food and water contaminated with benzene are not known. Animal studies indicate that oral exposure can damage the blood and immune system. Oral exposure of experimental animals to benzene has also been linked to cancer (ATSDR [Agency for Toxic Substances and Disease Registry], 1992, *Draft Toxicological Profile for Benzene. U.S. Dept. of Health and Human Services. Atlanta, GA*).

Diesel Fuels

Breathing diesel fuel vapors for long periods may damage the kidneys, increase blood pressure, and lower the blood's ability to clot. Skin contact, in large quantities over time, may also damage the kidneys.

Section 3
IDENTIFICATION OF THE REMOVAL ACTION OBJECTIVE

This section describes the removal action objective (RAO) and the scope of the removal action to address the presence of free-phase hydrocarbons in the groundwater and soil contamination at the Million Gallon Hill source area of the West Unit (ST009). As defined, an RAO is a site-specific, qualitative and/or quantitative goal that defines the extent of cleanup required for a removal action.

3.1 Objective of the Proposed Removal Action

The objective established for this removal action is to reduce and/or eliminate the existence of free-phase hydrocarbons and VOC soil contamination and to reduce the potential for volatiles to vaporize and collect in the buildings within and adjacent to this site. The goal of the removal action is to eliminate the source of volatile compounds so that inhalation of vapors does not occur. The removal of the floating product and the contaminated soil will eliminate the secondary source that is contributing to the risks detailed in the previous section. At present, there are no receptors of the groundwater downgradient of this area. The Yukon River lies approximately 2000 ft downgradient of this source area.

3.2 Identification and Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Although Galena Airport is not listed on the NPL, and the removal action is not driven by CERCLA from a regulatory standpoint, all removal actions are structured to follow CERCLA guidance. The CERCLA EE/CA guidance requires identification of ARARs, defined as follows:

- "Applicable" requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental laws that would be legally applicable if the removal or remediation were not taken under CERCLA; and
- "Relevant and appropriate" requirements are cleanup standards, standard of control, and other substantive environmental protection requirements, criteria, or limitations that address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well-suited to the particular site.

This section provides an overview of the pertinent ARARs for this removal action. The *RI Report* (USAF, 1995) provides a more detailed regulatory discussion, listing all requirements that are applicable or relevant and appropriate to the site as a whole. The discussion in the RI also presents "to be considered" information, which is not presented in this section.

The comprehensive list of ARARs in the RI was reviewed to determine which of them pertain directly to the design, construction, management, operation, discharge requirements, and so forth of each of the proposed removal action candidates for the Million Gallon Hill source area.

3.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are typically health-based or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. *The Guidance for Using Alaska Cleanup Matrix (UST and non-UST Soil)* (ADEC, 1994) establishes cleanup levels for DRO and GRO by assigning scores to the site characteristics and the receptors. Owing to the shallow depth to groundwater, the coarse grained nature of the soils, and the volume of contaminated soils, this area of soil contamination presents a moderately high (Level B) risk to the groundwater. This level translates into a cleanup level of 200 mg/kg of DRO in soil, which is the basis for the volume calculations and thusly the cleanup costs and durations for each of the alternatives presented.

Table 3-1 illustrates the guidance cited and shows the scoring process for the site characteristics and the subsequent matrix score for this area of contamination.

3.2.2 Location-Specific ARARs

No location-specific ARARs have been identified that may pertain to this removal action.

3.2.3 Action-Specific ARARs

The following air pollution regulations are ARARs that are relevant and appropriate if an air emission is created. Some or all of the following may apply:

- AS 46.03—Water, Air, and Energy Environmental Conservation;
- 18 AAC 50—Alaska Air Quality Control Regulations;
- 40 CFR Part 50—National Primary and Secondary Ambient Air Quality Standards;
- 40 CFR Part 60—Standards of Performance for New Stationary Sources; and
- 40 CFR Part 61—National Emission Standards for Hazardous Air Pollutants.

Table 3-1
Guidance for Using Alaska Cleanup Matrix
(UST and Non-UST Soil)

I. Matrix Score Sheet		
1. Depth to Subsurface Water < 5 feet 5 - 15 feet 15 - 25 feet 25 - 50 feet > 50 feet	 (10) (8) (6) (4) (1)	8
2. Mean Annual Precipitation > 40 inches 25 - 40 inches 15 - 25 inches < 15 inches	 (10) (5) (3) (1)	3
3. Soil Type (Unified Soil Classification) Clean, coarse-grained soils Coarse-grained soils with fines Fine-grained soil (low OC) Fine-grained soils (high OC)	 (10) (8) (3) (1)	8
4. Potential Receptors Public Well within 1000 feet, or Private Well(s) within 500 feet Municipal/private well within ½ mile Municipal/private well within 1 mile No known well within ½ mile No known well within 1 mile Nonpotable groundwater	 (15) (12) (8) (6) (4) (1)	8
5. Volume of Contaminated Soil > 500 cubic yards 100 - 500 cubic yards 25 - 100 cubic yards > De Minimis - 25 cubic yards De Minimis	 (10) (8) (5) (2) (0)	10
TOTAL SCORE		37

Matrix Score		Cleanup Level in mg/kg			
		Diesel		Gasoline/Unknown	
		Diesel Range Pet. Hydro.	Gasoline Range Pet. Hydro.	Benzene	BTEX
Level A	> 40	100	50	0.1	10
Level B	**27 - 40**	**200**	**100**	**0.5**	**15**
Level C	21 - 26	1000	500	0.5	50
Level D	< 20	2000	1000	0.5	100

Section 4
IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

The identification of removal action alternatives began with the exploration of the site characteristics and the identification of overall RAOs. This section describes and analyzes the actions that were selected for consideration based on their applicability to the site conditions (described in Section 2 of this document) and their ability to meet the action objective: to reduce and/or eliminate the potential that VOCs will migrate from the contaminated soils and accumulate in buildings located adjacent to the Million Gallon Hill site.

4.1 Removal Action Alternative Descriptions

Four removal action alternatives have been identified for exploration: natural attenuation (no action); LNAPL recovery with soil bioventing; LNAPL recovery with containment; and LNAPL recovery with soil excavation and treatment. These alternatives were chosen to meet action objectives and to investigate actions associated in whole or in part with each of the following remediation technology categories: natural degradation (Alternative 1), in situ remediation (Alternatives 2 and 3), and ex situ remediation (Alternative 4).

These removal action alternatives concentrate on protection of surrounding buildings from surface VOC exposure originating from migrating LNAPLs and associated soil contamination. The alternatives may constitute one step in the treatment of the site or may be used in conjunction with natural attenuation of the groundwater as a complete site action since there have been no exposure pathways to groundwater contamination identified other than the water supply wells (which are not threatened by conditions at Million Gallon Hill).

4.1.1 Alternative 1—No Action

This alternative was identified for analysis to provide a baseline for comparison. The no action alternative does not provide protection to human health or the environment. Contamination in the soil and groundwater is allowed to attenuate naturally and degrade over time with a continued source area in the LNAPL and contaminated soil.

4.1.2 Alternative 2—Free Product Recovery and Soil Bioventing

Alternative 2 focuses on the elimination of the continued sources of contamination—LNAPLs and the soil that they have contaminated. As described in Section 2, the seasonal fluctuations in groundwater elevation at the site have resulted in the contamination of the site soils that have come in contact with LNAPL floating on the groundwater surface (smearing). Under this alternative, floating LNAPLs on the groundwater will be recovered and the contaminated soil will be treated in place with bioventing.

Product-only recovery systems utilize a skimmer pump with a mechanism (hydrophobic filter or internal float and check valve) to exclude water from the pump reservoir. Typical removal rates by product-only systems range up to 2 gpm for pumps installed within 4-in. diameter wells. Bioventing involves the supply of air to subsurface soils by blowing air into wells screened in the unsaturated zone. Air travels through the soil, helping to volatilize and disperse contaminants and providing oxygen necessary for natural biodegradation.

Alternative 2 involves the location of product recovery wells adjacent to monitoring wells where free product has been observed. Bioventing wells will be arranged such that their zones of influence overlap to cover the area of suspected soil contamination. Some existing wells will be utilized for product recovery and/or bioventing, depending on their screened interval and the groundwater elevation.

4.1.3 Alternative 3—Containment

Alternative 3 involves source control accomplished by containing and removing the free product and restricting further migration and further soil contamination. This will be accomplished by the installation of a slurry wall or sheet piling downgradient of the area where free product has been observed, and the utilization of product recov-

ery wells installed upgradient of and along the barrier.

A slurry wall is a vertical subsurface barrier used to contain, capture, or redirect groundwater flow near a contaminated site. The slurry wall is a vertical trench that is excavated under a slurry and backfilled with a material that forms a low-permeability barrier.

Under this alternative, a slurry wall will be installed downgradient of the free-product area such that the depth of the wall is deeper than the minimum expected groundwater elevation. This will result in the containment of the free product, since it floats on the groundwater surface, and the groundwater surface will continually be above the bottom of the containment wall. LNAPL that collects along the upgradient side of the wall will be collected by product recovery pumps installed in the recovery wells. Dissolved contamination is expected to remain in the upper portions of the aquifer. Studies of the vertical distribution of groundwater contamination would be needed to determine the depth of the slurry wall.

4.1.4 Alternative 4—Product Recovery/Soil Excavation and Treatment

Alternative 4 involves the removal of continued source material by first removing the free product and then excavating all fuel-contaminated soil. Following sufficient product recovery, the soil will be excavated and treated on site by low-temperature thermal desorption. Treated soil will be tested and returned as backfill to the excavation. This alternative may not be appropriate for the large volume of soil to be treated but will be evaluated alongside the alternatives mentioned above for comparison and a representation of ex situ costs.

Product recovery wells will be installed as described in Alternative 2. After the LNAPL is removed, soil in the "smear zone" (between 8 and 25 ft below ground level) and beneath the leaking tank sites will be excavated for treatment. The volume of soil associated with this excavation is approximately 200,000 yd^3. The contaminated soil will be removed in sections placed in piles for treatment (estimated time period for degradation is three to four years) and returned to the excavation as backfill.

4.2 Analysis of Alternatives

The various removal action alternatives are evaluated in this section. In each case, an analysis of the effectiveness, implementability, and cost of each alternative is presented. Table 4-1 presents a synopsis of the criteria used in the evaluations, and Tables 4-2 through 4-5 present the evaluations of each of the four alternatives in turn. Supporting information for costs is provided in Appendix A of this document. Costs are reported as a combination of capital costs and one year of operations and maintenance costs.

Table 4-1
Removal Action Alternative Evaluation Criteria and Assessment System

Criterion Type	Evaluation Criterion	Definition	Condition
Effectiveness	Overall protection of human health/environment	Protection of human health and the environment is achieved through the reduction, control, or elimination of contaminated media.	Is protective
			Is not protective
	Compliance with ARARs	Complies with federal, state, or local environmental regulations or codes.	Complies with ARARs
			Does not comply
	Long-term effectiveness and performance	Protects human health and environment after the remedial objectives have been met.	Contaminants destroyed or removed
			Contaminants contained
			Contaminants not destroyed, removed, or encapsulated
	Reduction of toxicity, mobility, or volume through treatment	Reduction in toxicity, mobility, or volume of contaminated media to be treated.	Eliminates toxicity, mobility, and volume
			Reduces toxicity, mobility, and volume
			No reduction
	Short-term effectiveness	Protects human health and the environment during construction and implementation.	Minimal exposure of hazardous constituents during implementation
			Risks associated with implementing the action
			Risks associated with management of toxic byproduct of treatment
Implementability	Technical feasibility	Technical feasibility of implementing remedy.	Alternative uses proven technology
			Alternative is unproven
	Administrative feasibility	Feasibility of remedy meeting compliance with nonenvironmental laws/codes such as building permits and waivers.	Permitting available
			Uncertain permitting
	Availability of services and materials	Availability of services and materials required to implement remedy.	All personnel and materials available
			Personnel and materials critical to remedy implementation not available
	State acceptance	The state's (or other regulatory agency's) preference among or concerns about alternatives.	NA
	Community acceptance	The community acceptance of alternative.	NA
Cost	Capital	Cost of decision, construction, and startup remedy.	NC
	Annual O&M	Cost of operation, maintenance, and monitoring remedy.	NC

NA = Not available at the time of this report. This criterion is typically evaluated following comment on the EE/CA.
NC = No evaluation condition; cost criterion will be evaluated per dollar value.

Table 4-2
Alternative 1—No Action
Evaluation

Alternative 1: No Action	
Criteria	**Evaluation**
Overall protection of human health and the environment	The no action alternative will not protect human health or the environment. The potential will remain for the LNAPL to migrate and continue to contaminate the contacted soil, groundwater, and other nearby buildings.
Compliance with ARARs	No ARARs will be met.
Long-term effectiveness	The time for passive remediation to take place in the subsurface is unknown.
Reduction of toxicity, mobility, or volume	No reduction in toxicity, mobility, or volume of contamination. Volume of contamination could increase if LNAPL spreads, resulting in a larger "smear zone."
Short-term effectiveness	Not applicable to an alternative that has no duration.
Technical feasibility	Could be readily implemented from a technical standpoint.
Administrative feasibility	No permitting would be required, but the no action alternative would likely not be accepted by regulatory agencies.
Availability of services and materials	None required.
State acceptance	Addressed through response to review comments.
Community acceptance	Addressed through public meeting.
Cost	$0

Table 4-3
Alternative 2—Product Recovery/Soil Bioventing
Evaluation

Alternative 2: Product Recovery/Soil Bioventing	
Criteria	**Evaluation**
Overall protection of human health and the environment	Would prevent further contamination by removing the main sources of contamination (LNAPL and associated soil contamination) and preventing further migration of LNAPL.
Compliance with ARARs	Would comply with State of Alaska cleanup matrix for non-UST soils.
Long-term effectiveness	The source of fuel-related contamination would be removed. Residual contamination should pose no significant risk to human health.
Reduction of toxicity, mobility, or volume	The toxicity, mobility, and volume of the contaminated media would be eliminated in the soils. The toxicity would be reduced in the groundwater through dispersion.
Short-term effectiveness	Potential worker exposure to contaminants would be minimal owing to in situ treatment.
Technical Feasibility	Treatability studies have demonstrated the technical feasibility of this option.
Administrative feasibility	Administrative approvals needed to implement action should be readily obtainable.
Availability of services and materials	Personnel, equipment, and materials are readily available but may experience constraints posed by the remote location of the airport.
State acceptance	Addressed through response to review comments.
Community acceptance	Addressed through public meeting.
Cost (estimates located in Appendix A)	$571,344

Table 4-4
Alternative 3—Containment
Evaluation

Alternative 3: Containment—LNAPL Removal Combined with a Slurry Wall	
Criteria	**Evaluation**
Overall protection of human health and the environment	Would prevent migration of contamination by removing the main source of contamination (LNAPL) and reducing contact of uncontaminated groundwater with smeared soil and thus restricting spread of VOC contamination.
Compliance with ARARs	Would not comply with State of Alaska cleanup matrix for non-UST soils, although the exposure pathway may be eliminated.
Long-term effectiveness	The source of fuel-related contamination would be removed. Residual contamination should be contained and prevented from continued groundwater contamination. Residual contamination should pose no significant risk to human health.
Reduction of toxicity, mobility, or volume	The mobility of the contaminated groundwater would be reduced, but there is a possibility of contaminants passing under a slurry wall that is not deep enough. The toxicity and volume of contaminated groundwater would remain the same, unless intrinsic remediation would occur. The toxicity, mobility, and volumes of LNAPL and contaminated soil would be reduced.
Short-term effectiveness	Potential worker exposure to contaminants would be minimal except when handling extracted LNAPLs.
Technical feasibility	This technology appears to be technically feasible.
Administrative feasibility	Administrative approvals needed to implement action should be readily obtainable.
Availability of services and materials	Personnel, equipment, and materials are readily available but may experience constraints posed by the remote location of the airport.
State acceptance	Addressed through response to review comments.
Community acceptance	Addressed through public meeting.
Cost (estimates located in Appendix A)	$2,575,165

Table 4-5
Alternative 4—Product Recovery/Soil Excavation and Treatment Evaluation

Alternative 4: Product Recovery/Soil Excavation and Treatment by Low-Temperature Thermal Desorption	
Criteria	**Evaluation**
Overall protection of human health and the environment	Would prevent risks to human health posed by the migration of contamination by removing the sources of contamination: LNAPL and affected soils.
Compliance with ARARs	Would comply with State of Alaska cleanup matrix for non-UST soils.
Long-term effectiveness	The source of fuel-related contamination would be removed. The groundwater contamination will degrade naturally over time.
Reduction of toxicity, mobility, or volume	The toxicity, mobility, and volume of the contaminated soil and LNAPL would be eliminated. The toxicity of groundwater contamination would be reduced by dispersion and degradation.
Short-term effectiveness	Potential worker exposure to contaminants would be significant owing to excavation and handling of large volume of contaminated soils.
Technical feasibility	This technology may not be technically feasible. The volume of soil to excavate is excessive and would cause the technology to be cost prohibitive.
Administrative feasibility	Administrative approvals needed to implement action may not be readily obtainable.
Availability of services and materials	Personnel, equipment, and materials are readily available but may experience constraints posed by the remote location of the airport.
State acceptance	Addressed through response to review comments.
Community acceptance	Addressed through public meeting.
Cost (estimates located in Appendix A)	$106,783,385

Section 5
COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section draws on the results of the previous section in which each alternative was evaluated with respect to effectiveness, implementability, and cost, and compares their performance in terms of these criteria.

Alternative 1—No Action

- Effectiveness—This alternative is not effective in either reducing the concentration of VOCs or immobilizing the source of VOCs.

- Implementability—Although this alternative would be physically easy to implement, the public (or the state) would not accept this alternative.

- Cost—There is no cost associated with this option.

Alternative 2—Product Recovery and Soil Bioventing

- Effectiveness—This alternative removes both the remaining source of contamination (LNAPL) and residual contamination (smeared soils), thus restricting further migration of VOCs toward occupied buildings.

- Implementability—The product recovery would be easily implemented utilizing new and existing wells for product recovery. For new wells, drilling equipment and personnel can be provided by the Air Force. Bioventing is a proven technology with many successful examples of application. Bioventing can be implemented quickly with a moderate effort.

- Cost—The cost for this option is low to moderate considering the scope of the removal action.

Alternative 3—Containment

- Effectiveness—This alternative is effective in removing the primary source of VOCs (LNAPL). However, the secondary contaminant source (contaminated soils) would remain and provide a continuing source to groundwater. The effectiveness of a slurry wall (which would not be tied into a confining unit) is somewhat questionable. Also, the forces applied through frost heaving may jeopardize the integrity of the slurry wall.

- Implementability—This alternative is possible, but may be difficult to implement. New wells and existing wells could be utilized for product removal. For new wells, drilling equipment and personnel can be provided by the Air Force. The depth requirement (>50 ft below ground level) due to large fluctuation in groundwater level and the lack of a lower confining unit may pose a problem to slurry wall installation. Large equipment would have to be barged from larger cities. More investigative activities would be needed in order to determine how deep the slurry wall must be (based on the depth of contaminated groundwater).

- Cost—The cost for this alternative is very high.

Alternative 4—Product Recovery/Soil Excavation and Treatment

- Effectiveness—This alternative is effective in removing the source of VOCs by eliminating the LNAPL and contaminated soil. The groundwater contamination would be reduced over time (via natural attenuation).

- Implementability—This alternative would be extremely difficult to implement. The

excessive volume required for excavation (> 200,000 yd^3) makes this alternative technically complex. The operation of a continuous excavation and thermal treatment process would be time consuming. The process would also require large equipment (that would need to be barged in) and qualified personnel for a significant duration.

- Cost—The cost for this alternative is very high.

To illustrate and quantify the comparative analysis, a rating (from 0 through 10) was assigned to each of the evaluation criteria for each option. Zero represents the worst possible rating and 10 represents the best. The criteria are presented in Table 4-1.

Effectiveness—The no action alternative was given a rating of 0 for effectiveness because it does not meet any of the five requirements for the criterion. Alternatives 2 and 4 were rated 8 for effectiveness since they would be likely to physically remove more of the contaminant source material then the other options (but would probably not be able to remove 100% of the source material, and so were not rated 10). The containment alternative was given a rating of 3, since it would be capable of removing most of the LNAPL contamination but would leave residual soil contamination behind.

Implementability—Alternatives 2 and 3 were both readily performed, utilizing some existing wells and equipment available at the Airport; however, because the possible problems associated with the installation of a fairly deep slurry wall in the sandy soil, Alternative 3 was given a lower rating (5) than was Alternative 2 (8) for implementability.

Cost—There was no cost associated with the no action alternative, and it received the rating of 10 (least cost). Alternative 2 received a low to moderate cost rating, Alternative 3 received a low cost rating, and Alternative 4 received the worst cost rating of 0, indicating excessive cost.

Table 5-1 summarizes the ratings given to each criterion and provides a total rating (the sum of individual ratings) for each of the alternatives. The alternative with the most favorable rating is Alternative 2—Product Recovery with Soil Bioventing.

Table 5-1
Quantified Comparative Analysis of Alternatives

Technology	Effectiveness	Implementability	Cost	Total Rating
Alternative 1—No Action	0	3	10	13
Alternative 2—Product Recovery and Soil Bioventing	8	8	8	24
Alternative 3—Containment	3	5	4	12
Alternative 4—Product Recovery/Soil Excavation and Treatment	8	0	0	8

Section 6
RECOMMENDED ACTION ALTERNATIVE

This section summarizes the results of the removal action evaluation and comparison and recommends a plan of implementation.

6.1 Recommended Alternative

This EE/CA has examined four removal action alternatives for fuel-contaminated soils at the Million Gallon Hill source area of the Galena Airport West Unit (ST009):

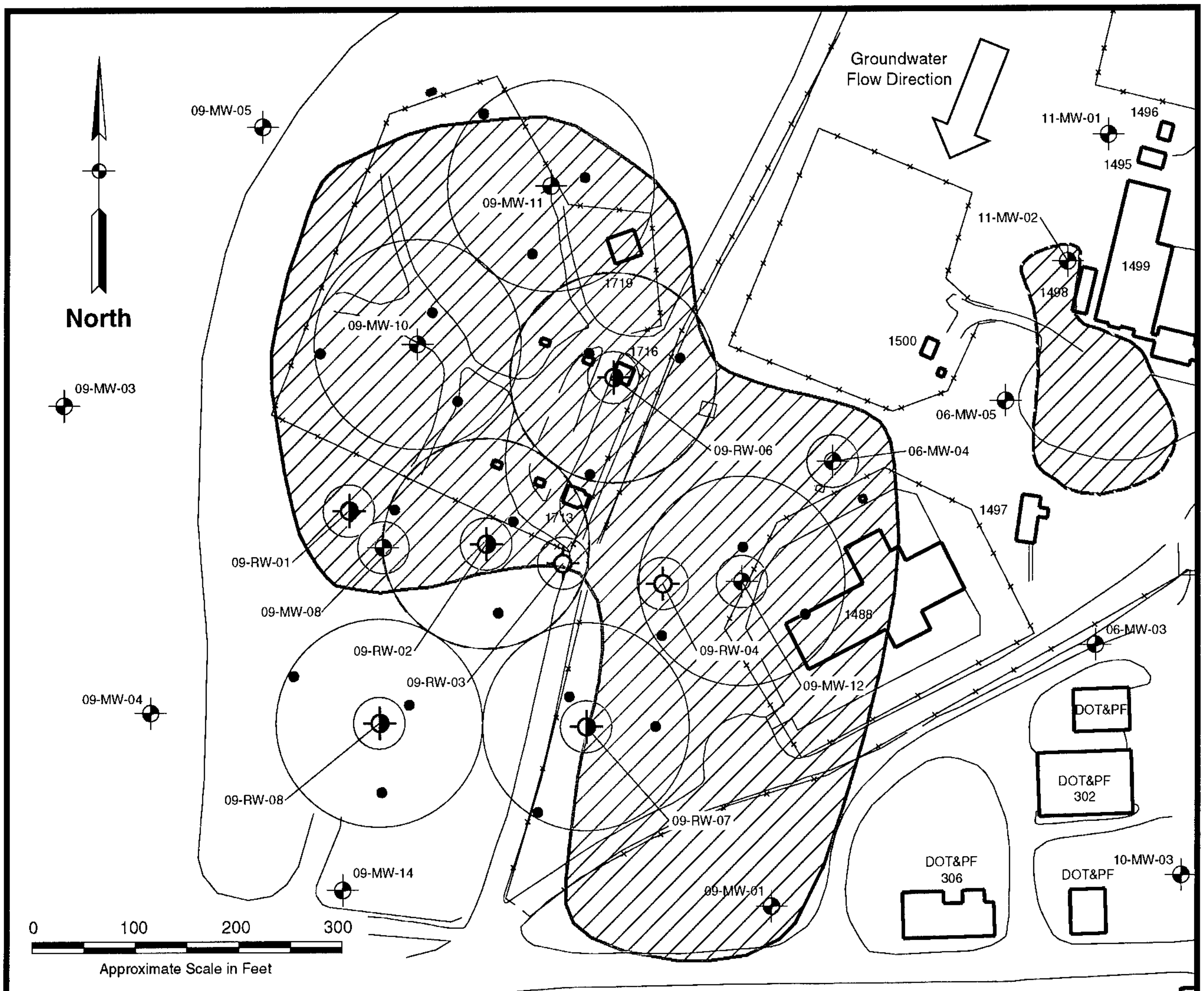
- **Alternative 1**—No action;
- **Alternative 2**—Product recovery and soil bioventing;
- **Alternative 3**—Containment; and
- **Alternative 4**—Product recovery Soil/ Excavation and treatment.

On the basis of the comparative analysis presented in Section 5, Alternative 2 was found to be the most feasible in terms of effectiveness, implementability, and cost.

6.2 Description of the Selected Alternative

Implementation of Alternative 2 should begin with the preparation of design drawings and specification for the product recovery and bioventing networks. Concurrently, a design analysis report should be prepared that will illustrate the decision-making process for components and the design basis for the system itself. After review of the plans and specifications, the equipment should be procured and materials purchased so that construction may begin.

A proposed layout for the selected alternative is shown in Figure 6-1 and includes bioventing-only locations, product-recovery locations, and locations where wells will be used as a product recovery well when the groundwater elevation is within the screened interval and as a bioventing well when the groundwater elevation drops below the screened interval. Three locations (two product-recovery-only wells and one combination well) will utilize existing monitoring wells. Product will be removed with a portable removal system, which can be moved from well to well and the product pumped into drums. It is anticipated that the recovered product will be recycled at the Airport. Bioventing will take place by pumping air into unsaturated zones of contaminated soil in order to remove volatiles and provide oxygen to facilitate natural biodegradation.



Million Gallon Hill

Proposed Layout of Product Recovery and Bioventing Systems & Extent of Contamination

Legend

- Existing 4" Monitoring Well
- Product Recovery/Bioventing Well
- Product Recovery Well
- Vapor Implants
- Product Recovery Zone of Influence
- Bioventing Zone of Influence
- Estimated Area of Soil Contaminated Above Screening Criteria (DRO >200 mg/kg)
- Estimated Area of Soil Contaminated Below Screening Criteria (DRO <200 mg/kg)

A1238-9 02/01/1996

Figure 6-1. Proposed Layout of Product Recovery and Bioventing Systems at Million Gallon Hill

Section 7
REFERENCES

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U.S. Air Force. *Installation Restoration Program Remedial Investigation Report, Galena Airport and Campion AFS, Alaska.* 1995.

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APPENDIX A
RACER COST DOCUMENTATION

Alternative 2
RACER Cost Documentation

PROJECT SUMMARY REPORT

GALENA MGH IN SITU
Free Product Recovery/Bioventing
Galena AK
SLW
05/26/95

Category		Amount
Studies	$	0
RA Capital		179,464
Site Work		0
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		0
General Conditions		91,647
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		13,556
Subtotal	$	284,667
Prime Contractor Profit - (Fee) (10.02%)		28,525
RA Operations and Maintenance		41,582
O&M Service Contract Overhead, Tax & Profit		9,441
Subtotal	$	364,215
Remedial Design		29,137
Subtotal	$	393,352
Escalation		46,144
Total Contract Costs	$	439,496
Contingencies (20.00%)		87,899
Project Management (10.00%)		43,949
Total Project Costs	$	571,344

********** END OF REPORT **********

PROJECT COST REPORT

GALENA MGH IN SITU
Free Product Recovery/Bioventing
Galena AK
SLW
05/26/95

	Start	Duration (months)	Escalation Date
RA Construction:	Jun 1996	3	Jul 1996
O&M:	Sep 1996	36	Mar 1998

* Escalation from Jan 1992

Project Comments:

	Studies	RA Construction	O&M
FPR+BIOVENT	$ 0	$ 179,464	$ 41,582
Total Direct Cost for Project:	$ 0	$ 179,464	$ 41,582

PROJECT COST REPORT

GALENA MGH IN SITU
Free Product Recovery/Bioventing
Galena AK
SLW
05/26/95

	Studies/ RA Construction	O&M
Total Direct Cost	$ 179,464	$ 41,582
Sales Tax:	0	0
General Conditions:	91,647	
Subcontractor Overhead:	0	
Subcontractor Profit:	0	
Bonds & Insurance:	0	2,080
Prime Contractor		
Professional Labor Overhead:	0	
Home Office Expense:	13,556	4,159
Prime Contractor Profit:	28,525	3,202
Subtotal	$ 313,192	$ 51,023
Remedial Design	29,137	
Subtotal	$ 342,329	$ 51,023
Escalation:	38,338	7,806
Total Contract Cost	$ 380,667	$ 58,829
Contingency (20.0%):	76,133	11,765
Project Management (10.0%):	38,066	5,882
Total Project Amount	$ 494,866	$ 76,476

********** END OF REPORT **********

* * * * This System Intended For Government Use Only * * * *

Alternative 3
RACER Cost Documentation

PROJECT SUMMARY REPORT

GALENA MGH CONTAIN
Galena EE/CA Million Gallon Hill Containment
Galena AK
SLW
05/26/95

Category		Amount
Studies	$	0
RA Capital		1,222,816
Site Work		20,502
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		7,342
General Conditions		182,940
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		71,314
Subtotal	$	1,504,914
Prime Contractor Profit - (Fee) (7.48%)		112,570
RA Operations and Maintenance		1,911
O&M Service Contract Overhead, Tax & Profit		436
Subtotal	$	1,619,831
Remedial Design		161,533
Subtotal	$	1,781,364
Escalation		199,533
Total Contract Costs	$	1,980,897
Contingencies (20.00%)		396,179
Project Management (10.00%)		198,089
Total Project Costs	$	2,575,165

********** END OF REPORT **********

PROJECT COST REPORT

GALENA MGH CONTAIN
Galena EE/CA Million Gallon Hill Containment
Galena AK
SLW
05/26/95

	Start	Duration (months)	Escalation Date
RA Construction:	May 1996	5	Jul 1996
O&M:	Jun 1996	12	Dec 1996

* Escalation from Jan 1992

Project Comments:

	Studies	RA Construction	O&M
CONTAINMENT	$ 0	$ 1,243,318	$ 1,911
Total Direct Cost for Project:	$ 0	$ 1,243,318	$ 1,911

PROJECT COST REPORT

GALENA MGH CONTAIN
Galena EE/CA Million Gallon Hill Containment
Galena AK
SLW
05/26/95

		Studies/ RA Construction		O&M
Total Direct Cost	$	1,243,318	$	1,911
Sales Tax:		0		0
General Conditions:		182,940		
Subcontractor Overhead:		2,176		
Subcontractor Profit:		5,166		
Bonds & Insurance:		0		96
Prime Contractor				
Professional Labor Overhead:		0		
Home Office Expense:		71,314		192
Prime Contractor Profit:		112,570		148
Subtotal	$	1,617,484	$	2,347
Remedial Design		161,533		
Subtotal	$	1,779,017	$	2,347
Escalation:		199,246		286
Total Contract Cost	$	1,978,263	$	2,633
Contingency (20.0%):		395,652		526
Project Management (10.0%):		197,826		263
Total Project Amount	$	2,571,741	$	3,422

********** END OF REPORT **********

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Alternative 4
RACER Cost Documentation

PROJECT SUMMARY REPORT

GALENA MGH DIG/COMP

Galena AK
slw
05/30/95

Category		Amount
Studies	$	0
RA Capital		60,942,159
Site Work		699,222
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		1,431,672
General Conditions		996,905
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		1,565,958
Subtotal	$	65,635,916
Prime Contractor Profit - (Fee) (5.13%)		3,370,462
RA Operations and Maintenance		1,274
O&M Service Contract Overhead, Tax & Profit		291
Subtotal	$	69,007,943
Remedial Design		6,489,331
Subtotal	$	75,497,274
Escalation		6,643,792
Total Contract Costs	$	82,141,066
Contingencies (20.00%)		16,428,213
Project Management (10.00%)		8,214,106
Total Project Costs	$	106,783,385

********** END OF REPORT **********

* * * * This System Intended For Government Use Only * * * *

PROJECT COST REPORT

GALENA MGH DIG/COMP

Galena AK
slw
05/30/95

	Start	Duration (months)	Escalation Date
RA Construction:	Apr 1995	3	May 1995
O&M:	Apr 1996	5	Jun 1996

* Escalation from Jan 1992

Project Comments:

	Studies	RA Construction	O&M
EXCAVATE	$ 0	$ 61,641,381	$ 1,274
Total Direct Cost for Project:	$ 0	$ 61,641,381	$ 1,274

PROJECT COST REPORT

GALENA MGH DIG/COMP

Galena AK
slw
05/30/95

		Studies/ RA Construction		O&M
Total Direct Cost	$	61,641,381	$	1,274
Sales Tax:		0		0
General Conditions:		996,905		
Subcontractor Overhead:		462,311		
Subcontractor Profit:		969,361		
Bonds & Insurance:		0		64
Prime Contractor				
Professional Labor Overhead:		0		
Home Office Expense:		1,565,958		128
Prime Contractor Profit:		3,370,462		99
Subtotal	$	69,006,378	$	1,565
Remedial Design		6,489,331		
Subtotal	$	75,495,709	$	1,565
Escalation:		6,643,619		173
Total Contract Cost	$	82,139,328	$	1,738
Contingency (20.0%):		16,427,865		347
Project Management (10.0%):		8,213,932		173
Total Project Amount	$	106,781,125	$	2,258

********** END OF REPORT **********